Semester I			
Core IV	**Mathematical Statistics**		
Course Code: 21PMAC14	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Course Objectives

- To enable the use of statistical techniques whenever relevant.
- To have a proper understanding of statistical applications in real life.

Course Outcome

CO.NO.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	explain the concepts of distributions and apply them.	2,8	Un
CO-2	examine the method used for analysis, including a discussion of advantages, disadvantages and necessary assumptions.	1,2	An
CO-3	apply discrete and continuous probability to evaluate the probability of real world events.	2,7	Ap
CO-4	compare the distribution with one another.	2,8	An
CO-5	apply the concepts of random variable, probability distribution, distribution function, expected value, variance and higher moments, and calculate expected values and probabilities associated with the distributions of random variables	2,7,8	Ap
CO-6	define a probability generating function, a moment generating function and derive them in simple cases.	5,8	Re

Semester I			
Core IV	**Mathematical Statistics**		
Course Code: 21PMAC14	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Unit I

Distribution of Two Random Variables – Conditional Distributions and Expectations-The correlation coefficient-Independent Random Variables-Extension to Several Random Variables.

(Chapter 2: Sections 2.1, 2.2, 2.3, 2.4, 2.5)

Unit II

Some special Distributions: The Binomial and Related Distributions – The Poisson Distribution - The Gamma and Chi-square Distributions – The Normal Distribution – The Bivariate Normal Distribution.

(Chapter 3: Sections 3.1, 3.2, 3.3, 3.4, 3.5)

Unit III

Distributions of functions of Random variables: Sampling theory – Transformations of variables of the discrete type – Transformations of variables of the continuous type – The Beta, t, and F Distributions.

(Chapter 4: Sections 4.1, 4.2, 4.3, 4.4)

Unit IV

Extensions of the Change of variable technique – Distributions of Order statistics – The Moment generating function technique – The Distributions of$\bar{X}$ and nS^2/σ^2 – Expectations of functions of random variables.

(Chapter 4: Sections 4.5, 4.6, 4.7, 4.8, 4.9)

Unit V

Limiting Distributions: Convergence in Distribution – Convergence in Probability – Limiting Moment Generating Function – The central limit theorem – Some theorems on Limiting Distributions.

(Chapter 5: Sections 5.1, 5.2, 5.3, 5.4, 5.5)

Text Book

1. Robert V. Hogg and AllenT.Craig. *Introduction to Mathematical Statistics*. Pearson Education Asia. Fifth edition, 2004.

Books for Reference

1. J.N.kapur, H.C. Saxena. *Mathematical Statistics*. S.Chand& Co, 2013.
2. Keith Knight. *Mathematical Statistics*. New York. Chapman & Hall/CRC, 2000.

Semester I			
Elective I A	**Combinatorics**		
Course Code:21PMAE11	**Hrs/week: 6**	**Hrs/Sem:90**	**Credits: 4**

Course Objectives

- To understand and demonstrate the basic concept of an algorithm and its applications in combinatorial mathematics.
- To emphasise on the importance of enumeration tools and techniques in diverse branches of mathematics and Applied Fields

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	explain the properties and behaviour of permutations and combinations.	1, 6	Un
CO-2	solve problems involving strings, combinations, distributions and partitions.	2	Ap
CO-3	understand the ideas of permutations and combinations.	1,6	Un
CO-4	apply, implement and interpret the theory of combinatorics to relevant probability and statistics problems.	2	Ap
CO-5	evaluate the addition and multiplication principles of counting.	3	Ev
CO-6	apply diverse counting strategies to solve varied problems involving combinations and distributions	2,3	Ap

Semester I			
Elective I A	**Combinatorics**		
Course Code: 21PMAE11	**Hrs/week: 6**	**Hrs/Sem:90**	**Credits: 4**

Unit I

Permutations and Combinations: Introduction, rules of sum and product-Permutations and Combinations - Distributions of distinct objects - distributions of non - distinct objects.

(Chapter 1: Sections: 1.1 -1.6)

Unit II

Generating Functions: Generating functions for combinations - enumerators for permutations- Distributions of distinct objects into non- distinct cells - partitions of integers.

(Chapter 2: Sections: 2.1 -2.5)

Unit III

Recurrence Relations: Linear Recurrence relations with constant coefficients - Solution by the technique of generating functions - A special class of nonlinear difference equations - Recurrence relation with two indices.

(Chapter 3: Sections: 3.1 - 3.5)

Unit IV

The Principle of Inclusion and exclusion: The principle of Inclusion and Exclusion - the general formula – Derangements - Permutations with restrictions on relative positions.

(Chapter 4: Sections: 4.1 -4.5)

Unit V

Polya's Theory of Counting: Equivalence classes under a permutation group-Equivalence classes of functions - Weights and inventories of functions -Polya's fundamental theorem.

(Chapter 5: Sections: 5.3 -5.6)

Text Book

1. C. L. Liu. *Introduction to Combinatorial Mathematics*. McGraw Hill publications, 1968.

Books for Reference

1. Normal L. Biggs. *Discrete Mathematics*. Oxford University Press, 2002.

2. J.Hein. *Discrete Structures, Logic and Computability*. Jones and Barlett, 2002.

Semester - II			
Core IX	**Stochastic Processes**		
Course Code: 21PMAC25	**Hrs/week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Course Objectives

- To acquire knowledge about stochastic process relying on the probability theory and mathematical analysis.
- To develop comprehensive knowledge of Probability Distribution, Transition Probabilities, Markov Chains, Birth – Death Process.

Course Outcome:

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	illustrate the stochastic model.	8	Un
CO-2	explain the well known models like birth-death and queueing to reorient their knowledge of stochastic analysis.	7	Un
CO-3	analyze the transition probabilities and its classifications.	2	An
CO-4	compare the different stochastic models.	1,8	An
CO-5	understand the notions of stochastic process.	5	Un
CO-6	apply markov chains to practical problems	4	Ap

Semester - II			
Core IX	**Stochastic Processes**		
Course Code: 21PMAC25	**Hrs/week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Unit I

Generating functions - Laplace Transforms - Laplace Transforms of a Probability Distribution or of a Random variable - Difference Equations - Difference Equations in Probability Theory.

(Chapter1: Sections: 1.1 - 1.5)

Unit II

Differential- Difference Equations - Matrix analysis. Stochastic Process: Notion of Stochastic process - Specification of Stochastic Process.

(Chapter 1: Sections: 1.6, 1.7 and Chapter 2: Sections: 2.1 - 2.3)

Unit III

Higher transition probabilities and classification of states - Higher transition probabilities - Classification of states and chains - Determination of Higher transition probabilities -Stability of Markov system: Limiting Behavior.

(Chapter 3: Sections: 3.1 - 3.5)

Unit IV

Statistical inference for Markov Chains-Markov chains with continuous state space-Non-stationary or Non-homogeneous chains-Poisson process-Poisson process and Related Distributions.

(**Chapter 3: Sections: 3.6-3.8 and Chapter4: Sections: 4.1 - 4.2)**

Unit V

Generalizations of Poisson Process-Birth and Death process-Markov Processes-Discrete State Spaces-Erlang Process.

(Chapter 4: Sections: 4.3 - 4.6)

Text Book:

1. J.Medhi. *Stochastic Process*. Wiley Eastern Limited, 1982.

Books for Reference:

1. SrinivasanMehata. *Stochastic Process*. New Delhi: Tata McGraw-Hill Publishing Company Limited, 1976.
2. Tapas kumar Chandra and SreelaGangopadhyay. *Introduction to Stochastic Process*, Narosa Publishing House, 2018.

Semester II			
Elective II A	**Operations Research**		
Course Code: 21PMAE21	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 3**

Course Objectives

- To use quantitative methods and techniques for effective decision –making; model formulation and applications that are applied to problems in business, industry and society.
- To provide a theoretical introduction and implementation of optimization techniques in order to get best results from a set of serial possible solution of different problems.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	classify and formulate integer programming problems and solve them with Cutting Plane Algorithm, Branch and Bound Algorithm.	2,4	Ap
CO-2	solve classical dynamic programming problems.	2,6	Ap
CO-3	compare inventory models and other related models.	2	An
CO-4	analyze a network of queues with Poisson external arrival, exponential service requirements and independent routing.	1,6	An
CO-5	evaluate the concept of complementary slackness and its role in solving prime and dual problems	2	Ev
CO-6	define probabilistic inventory models that accounts for all variations in real systems.	2	Re

Semester II			
Elective II A	**Operations Research**		
Course Code: 21PMAE21	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 3**

Unit I

Integer Programming: Some Applications of Integer Programming Solution Algorithms-Methods of Integer Programming - Cutting Plane Algorithm - Branch and Bound Algorithm.

(Chapter 8: Sections 8.1, 8.2, 8.3, 8.4)

Unit II

Dynamic Programming: Elements of DP Model - The Capital Budgeting Example - Cargo-Loading Problem- Reliability Problem - Work Force Size Problem - Forward and Backward Recursive equations.

(Chapter 9: Sections 9.1, 9.2, 9.3)

Unit III

Inventory Models: The ABC Inventory System - A generalized inventory model - Deterministic models: Single item static model and multiple item static model.

(Chapter 13: Sections 13.1, 13.2, 13.3)

Unit IV

Inventory Models: Probabilistic models– A continuous review model-Single Period Models: Instantaneous Demand, No Setup Cost and s-S Policy

(Chapter 13: Sections 13.4(13.4.1, 13.4.2))

Unit V

Queueing Theory: Elements of Queueing model - Roles of the Poisson and Exponential Distributions - Arrivals Process- Departures Process

(Chapter 15: Sections 15.1, 15.2)

Text Book

1. Hamdy A. Taha. *Operations Research an Introduction*. New York: Macmillan Publishing Company, Fourth Edition, 1987.

Books for Reference

1. J.K.Sharma. *Operations Research.* Macmillan Publishers India Ltd, 2007.
2. KantiSwarup, P.K.Kupta and Man Mohan. *Operations Research*. Sultan Chand & Sons Publications, 2013.

Semester III			
Elective III A	**Fluid Mechanics**		
Course Code: 21PMAE31	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 3**

Course Objectives

- To introduce fundamental aspects of fluid flow behaviour and to develop steady state mechanical energy balance equation for fluid flow systems.
- To estimate pressure drop in fluid flow systems and determine performance characteristics of fluid machinery.

Course Outcome

CO.No.	Upon completion of this course, students will be able to	PSO Addressed	CL
CO-1	explain fundamentals of fluid mechanics, which is used in the applications of Hydraulics.	1,8	Un
CO-2	classify hydrostatic law, principle of buoyancy and stability of a floating body and application of mass, momentum and energy equation in fluid flow.	2	Ap
CO-3	examine stability of submerged and floating bodies.	6	An
CO-4	differentiate horizontal motion and vertical motion.	1	An
CO-5	describe methods of implementing fluid mechanics laws and phenomena.	5,6	Re
CO-6	calculate and optimize operational parameters of hydraulic problems, systems and machines	2	Ap

Semester III			
Elective III A	**Fluid Mechanics**		
Course Code: 21PMAE31	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 3**

Unit I

Properties of Fluids: Viscosity - Thermodynamic properties- Compressibility and Bulk modulus - Surface Tension and Capillarity - Vapour Pressure and Cavitation.

(Chapter 1: Sec 1.1 – 1.7)

Unit II

Pressure and its measurement: Fluid pressure of a point - Pascal's Law - Pressure variation in a fluid at rest - Absolute, Gauge, Atmospheric and Vacuum Pressure - Measurement of pressure - Simple manometer - Differential Manometer - Pressure at a point in Compressible fluid.

(Chapter 2: Sec 2.1 – 2.8)

Unit III

Hydrostatic forces on Surfaces: Total pressure and Centre of Pressure- Vertical Plane Surfaces submerged in liquid - Horizontal Plane Surfaces submerged in liquid -Inclined Plane Surface submerged in liquid - Curved Surface submerged in liquid

(**Chapter 3: Sec 3.1-3.6)**

Unit IV

Total Pressure and Centre of pressure on lock gates - Pressure Distribution in a liquidsubjected to Horizontal/Vertical Acceleration.

(Chapter3:Sec3.7-3.9)

Unit V

Buoyancy and flotation: Buoyancy - Centre of Buoyancy - Metacentre - Metacentric height - Conditions of Equilibrium of a Floating and Submerged bodies - Experimental Method of Determination of Meta - centric Height - Oscillation of a floating body.

(Chapter 4 Sec 4.1 – 4.9)

Text Book

1. Dr.R.K. Bansal. *A text book of Fluid Mechanics*. Laxmi Publication private limited, Tenth edition.

Books for Reference

1. Joseph H.Spurk, NuriAksel. *Fluid Mechanics*. Springer- Verlag Berlin Heidelberg, Second Edition, 2008.
2. Ranald V. Giles. *Fluid Mechanics and Hydraulics*. McGraw - Hill Book Company, Second Edition.

Semester – III			
Elective III B	**Wavelet Analysis**		
Course Code: 21PMAE32	**Hrs/week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Course Objectives

- To establish the theory necessary to understand and use wavelets and related constructions
- To apply wavelets, filter banks and multi irresolution techniques to a problem.

Course Outcome:

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	understand wavelet basis and characterize continuous and discrete wavelet transform	2	Un
CO-2	understand multi resolution analysis and identify various wavelets and evaluate their time frequency resolution properties	3	Un
CO-3	discuss and explain the main merits and limitations of wavelet analysis	2	An
CO-4	explain the properties and applications of wavelet transform	1	Un
CO-5	explain brief features and strength of transform beyond wavelet.	2	Un
CO-6	analyse the basis of the application of wavelet transforms to different fields	1,6	An

Semester – III			
Elective III B	**Wavelet Analysis**		
Course Code: 21PMAE32	**Hrs/week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Unit I

Motivation and Heuristics - Heuristics Treatment of the Wavelet Transform - Wavelet Transform - Wavelet Characterization of Smoothness - Haar Wavelet Expansion - Haar Functions and Haar Series - Haar Sums and Dyadic Projections - Completeness of the Haar Functoins. **(Chapter: 6, Sec: 6.1 - 6.3, except 6.3.4 - 6.3.7)**

Unit II

Multi resolution Analysis - Orthonormal System and Riesz Systems - Scaling Equations and Structure Constants - From Scaling Function to MRA - Meyer Wavelets - From Scaling Function to Orthonormal Wavelet.

(Chapter: 6, Sec 6.4)

Unit III

Wavelets with Compact Support - From Scaling Filter to Scaling Function - Explicit Construction of Compact Wavelets - Smoothness of Wavelets - Cohen's Extension

(Chapter: 6, Sec: 6.5)

Unit IV

Convergence Properties of Wavelet Expansions - Wavelet Series in L^P Spaces - Jackson and Bernstein Approximation Theorems. (**Chapter: 6, Sec: 6.6)**

Unit V

Wavelets in Several Variables - Two important Examples - General Formulation of MRA and Wavelets in R^d - Examples of Wavelets in R^d. **(Chapter: 6, Sec: 6.7)**

Text Book:

1. Mark A. Pinsky. *Introduction to Fourier Analysis and Wavelets*. Published by the American Mathematical Society, First Indian Edition, 2015.

Books for Reference:

1. E. Hernandez and G. Weiss. *A First Course on Wavelets*. CRC Press, 1996.
2. L. Prasad & S.S. Iyengar. *Wavelet Analysis with Applications to Image Processing.* CRC Press, 1997.

Semester IV			
Core XVII	**Number Theory and Cryptography**		
Course Code:21PMAC43	**Hrs/week: 5**	**Hrs/Sem:75**	**Credits: 4**

Course Objectives

- To introduce the basic concepts of Number Theory such as Divisibility, Congruences, Congruences with Prime Modules, Quadratic Reciprocity and some functions of Number theory.
- To understand basics of cryptography and network security.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO Addressed	CL
CO-1	define the key notions of algebraic number theory and outline their interrelation.	5	Re
CO-2	calculate the most important number theoretical quantities introduced during the course.	5	Re
CO-3	calculate and solve the system of linear congruences and warning problem.	2,6	Re
CO-4	differentiate the greatest integer functions and arithmetic function.	1,6	An
CO-5	explains the notions of public key encryption and digital signatures.	6	Un
CO-6	describe and implement the specifics of some of the prominent techniques for public key crypto systems and digital signature schemes	6	Re

Semester IV			
Core XVII	**Number Theory and Cryptography**		
Course Code:21PMAC43	**Hrs/week: 5**	**Hrs/Sem:75**	**Credits: 4**

Unit I

Divisibility - primes - Congruences - Solutions of Congruences - Congruences of degree one.

(Text Book 1, Chapter: 1 & 2, Sections: 1.1, 1.2, 1.3, 2.1, 2.2, 2.3)

Unit II

Quadratic residues - quadratic reciprocity - The Jacobi symbol.

(Text Book 1, Chapter 3, Sections: 3.1, 3.2, 3.3)

Unit III

Greatest integer Function -Arithmetic functions- The Moebius inversion formula- Multiplication of Arithmetic functions.

(Text Book 1, Chapter: 4 Sections: 4.1, 4.2, 4.3, 4.4)

Unit IV

The equation $x^2+ y^2=z^2$- The equation $x^4+y^4=z^2$ - sum of four and five squares -Waring's problem: Sum of fourth powers-sum of two squares.

(Text Book 1, Chapter: 5, Sections: 5.5, 5.6, 5.7, 5.8, 5.9, 5.10)
(without Exercise problems)

Unit V

The Basics of Cryptography: Encryption and decryption - What is cryptography? - Conventional cryptography - Public key cryptography - How PGP works - Keys - Digital Signatures - Digital certificates - Validity and trust - Certificate Revocation - What is passphrase? RSA: Principles of Public - key Cryptosystems - The RSA Algorithm.

(Text Book 2, Chapter 1, Text Book 3, Chapter 9)

Text Book

1. Ivan Niven and Herbert S. Zuckerman. *An introduction to the theory of numbers*. Wiley Eastern ltd, Third Edition, 1976.
2. PGP Corporation. *An introduction to Cryptography*. version 8.0, Released Oct, 2002.
3. William Stallings. *Cryptography and Network Security Principles and Practice*. Pearson India Education Services Pvt.Ltd, Seventh Edition.

Books for Reference

1. Harriet Griffin. *Elementary Theory of Numbers*. McGraw-Hall Book Company, INC 1954.
2. G.H. Hardy and E.M. Wright. *An Introduction to the theory of numbers*. Oxford university press, Sixth Edition, 2008.
3. Mohamed Barakat, Christian Eder and Timohanke. *An Introduction to Cryptography*. September 20, 2018.

Semester IV			
Elective IV A	**Differential Geometry**		
Course Code: 21PMAE41	**Hrs/Week: 5**	**Hrs/Sem: 75**	**Credits: 4**

Course Objectives

- To focus on the geometry of curves and surfaces in 3-dimensional Euclidean space.
- To find and use the shortest paths on a surface and explore the relationship between the length of a curve and the area bounded by it.

Course Outcome:

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO -1	construct a variety of geometrical objects.	1	Ap
CO-2	acquire the essential ideas about the theory of space curves.	6	Re
CO-3	analyze the different consequences and meanings of parallelism on Euclidean and hyperbolic planes.	1	An
CO-4	demonstrate the knowledge of family of curves, geodesics and the fundamental forms.	1,6	Un
CO-5	use concrete models to demonstrate geometric concepts	2	Ap
CO-6	evaluate the principal curvatures, the mean curvature and Gauss curvature of a given surface.	2,6	Ev

Semester IV			
Elective IV A	**Differential Geometry**		
Course Code: 21PMAC44	**Hrs/Week :5**	**Hrs/Sem: 75**	**Credits: 4**

Unit I

The Theory of Space Curves: Introductory Remarks about Space Curves - Definitions - Arc Length - Tangent, Normal and Binormal - Curvature and Torsion of a curve given as the intersection of two Surfaces.

(Chapter 1: Sections 1, 2, 3, 4, 5)

Unit II

Contact between Curves and surfaces - Tangent Surface, Involutes and Evolutes. Intrinsic Equations, Fundamental Existence Theorem for Space Curves - Helices.

(Chapter 1: Sections 6, 7, 8, 9)

Unit III

The Metric: Local Intrinsic Properties of a Surface: Definition of a Surface - Curves on a Surface - Surfaces of Revolution - Helicoids - Metric - Direction Coefficients.

(Chapter 2: Sections 1, 2, 3, 4, 5, 6)

Unit IV

Families of Curves - Geodesics - Canonical Geodesic Equations - Normal Property of Geodesics.

(Chapter 2: Sections 7, 10, 11, 12)

Unit V

The Second and Fundamental form: The Second and Fundamental form - Principal curvatures - Lines of Curvature - Geodesic Parallel - Geodesic curvature.

(Chapter 2: Sections 14, 15 & Chapter 3: Sections 1, 2, 3)

Text Book

1. T.J.Wilmore. *An Introduction to Differential Geometry*. Oxford University Press, 2007.

Books for Reference

1. Dirk J.Struik. *Lectures on Classical Differential Geometry*. Addison Wesley Publishing House, Second Edition,
2. William C.Graustein. *Differential Geometry.* New York: Dover Publications, 1962.

Semester IV			
Elective B	**Projective Geometry**		
Course Code: 21PMAE42	**Hrs/Week: 5**	**Hrs/Sem: 75**	**Credits: 4**

Objectives

- To acquire the essential ideas and methods of Projective Geometry.
- To study the properties of geometric objects such as curves and surfaces in terms of algebraic equations

Course Outcome:

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO -1	describe geometric objects and properties with the homogeneous coordinates of the projective plane	1	Ap
CO-2	study the angle between the corresponding lines in 3-dimensional space	5	Un
CO-3	demonstrate a deep understanding of the axiomatic approach to projective spaces	1	An
CO-4	perform calculations in desarguesian planes and projective 3- spaces	5	Un
CO-5	classify the structure of collineations of projective planes	1,6	Un
CO-6	demonstrate an understanding of theory of conics in field planes	2	Ap

Semester IV			
Elective B	**Projective Geometry**		
Course Code: 21PMAE42	**Hrs/Week :5**	**Hrs/Sem: 75**	**Credits : 4**

UNIT-I

Projective Geometry as an extension of high school geometry: Two approaches to projective geometry-An initial question-Projective invariants-Vanishing points - Vanishing lines- Some projective noninvariants-Betweenness-Division of a segment in a ratio-Desargues' Theorem-Perspectivity;projectivity-Harmonic tetrads;fourth harmonic-Further theorems on harmonic tetrads. **(Chapter 1: Sections 1-12)**

UNIT-II

Projective Geometry as an extension of high school geometry: The cross – ratio-Fundamental Theorem of Projective Geometry-Further remarks on the cross – ratio-Construction of the projective plane- Previous results in the constructed plane-Analytic construction of the projective plane. **(Chapter 1: Sections 13-18)**

UNIT-III

The axiomatic foundation: Unproved propositions and undefined terms-Requirements on the axioms and undefined terms-Undefined terms and axioms for a projective plane-Initial development of the system; the Principle of Duality-Consistency of the axioms-Other models-Independence of the axioms-Isomorphism-Further axioms-Consequences of Desargues' Theorem-Free planes. **(Chapter 2: Sections 1-11)**

UNIT-IV

Establishing coordinates in a plane: Definitions of a field-Consistency of the field axioms-The analytic model - Geometric description of the operations plus and times- Setting up coordinates in the projective plane-The non commutative case.

(Chapter 3: Sections 1-6)

UNIT-V

Relations between the basic theorems & Axiomatic introduction of Higher - dimensional space: Higher - dimensional, especially 3-dimensional projective space-Desarguesian planes and higher - dimensional space. **(Chapter 4 & 5: Sections 1-2)**

Text Book:

1. A.Seidenberg. *Lectures In Projective Geometry*. New York: Van Nostrandrein hold Company, 1965.

Reference:

1. Herbert Busemann and Paul J. Kelly. *Projective Geometry and Projective Matrics*. NewYork: Academic Press INC Publishers, 1953.

Semester I			
Core IV	**Mathematical Statistics**		
Code: 19PMAC14	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Vision

To provide students with a solid grounding in probability theory and mathematical statistics.

Mission

To teach the main principles and methods of mathematical solutions and develop the students ability to analyze and think logically.

Course Outcome

CO.NO.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	explain the concepts of distributions and apply them.	2,8	Un
CO-2	provide a description of the method used for analysis, including a discussion of advantages, disadvantages and necessary assumptions.	1,2	An
CO-3	apply discrete and continuous probability to evaluate the probability of real world events.	2,7	Ap
CO-4	provide a conclusion to the study including a discussion of limitations of the analysis.	2,8	An
CO-5	test statistical hypothesis.	2	Cr
CO-6	explain the concepts of random variable, probability distribution, distribution function, expected value, variance and higher moments, and calculate expected values and probabilities associated with the distributions of random variables	2,7,8	Un
CO-7	define a probability generating function, a moment generating function and derive them in simple cases.	5,8	Re
CO-8	state the central limit theorem, and apply it.	1,5	Ap

Semester I			
Core IV	**Mathematical Statistics**		
Code: 19PMAC14	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Unit I

Some special Distributions: The Binomial and Related Distributions – The Poisson Distribution - The Gamma and Chi-square Distributions – The Normal Distribution – The Bivariate Normal Distribution. **(Chapter 3: Sections 3.1, 3.2, 3.3, 3.4, 3.5)**

Unit II

Distributions of functions of Random variables: Sampling theory – Transformations of variables of the discrete type – Transformations of variables of the continuous type – The Beta, t, and F Distributions. **(Chapter 4: Sections 4.1, 4.2, 4.3, 4.4)**

Unit III

Extensions of the Change of variable technique – Distributions of Order statistics – The Moment generating function technique – The Distributions of$\bar{X}$ and nS^2/σ^2 – Expectations of functions of random variables. **(Chapter 4: Sections 4.5, 4.6, 4.7, 4.8, 4.9)**

Unit IV

Limiting Distributions: Convergence in Distribution – Convergence in Probability – Limiting Moment Generating Function – The central limit theorem – Some theorems on Limiting Distributions. **(Chapter 5: Sections 5.1, 5.2, 5.3, 5.4, 5.5)**

Unit V

Theory of statistical tests: Certain best tests - Uniformly most powerful tests-Likelihood ratio test. (**Chapter 8 and 9, Sections 8.1, 9.1, 9.2, 9.3)**

Text Book

1. Robert V.Hogg and AllenT.Craig: Introduction to Mathematical Statistics, fifth edition, Pearson Education Asia, 2004.

Books for Reference

1. J.N.kapur, H.C. Saxena: Mathematical Statistics, S.Chand & Co, 2013.
2. Keith Knight: Mathematical Statistics, Chapman & Hall/CRC, New York, 2000.

Semester I			
Core V	**Operations Research**		
Code: 19PMAC15	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Vision

To acquire a thorough knowledge of algorithms such as Branch and Bound algorithm, Cutting plane algorithm etc.

Mission

To provide mathematical techniques to model and analyze decision problems with effective application to real life.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	classify and formulate integer programming problems and solve them with Cutting Plane Algorithm, Branch and Bound Algorithm.	2,4	Un
CO-2	formulate and solve classical dynamic programming problems.	2,6	Un
CO-3	formulate and solve inventory models and other related models.	2	Un
CO-4	understand and solve problems regarding decision theory and game theory.	2	Un
CO-5	analyze a network of queues with Poisson external arrival, exponential service requirements and independent routing.	1,6	An
CO-6	explain the concept of complementary slackness and its role in solving prime and dual problems	2	Un
CO-7	set up decision models and use some solutions method for nonlinear optimization problems.	2,6	Cr
CO-8	propose the best strategy using decision making methods under uncertainty and game theory.	2	Ev

Semester I			
Core V	**Operations Research**		
Code: 19PMAC15	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Unit I

Integer Programming: Some Applications of Integer Programming Solution Algorithms-Methods of Integer Programming - Cutting Plane Algorithm - Branch and Bound Algorithm.

(Chapter 8: Sections 8.1, 8.2, 8.3, 8.4)

Unit II

Dynamic Programming: Elements of DP Model - The Capital Budgeting Example - Cargo-Loading Problem- Reliability Problem - Work Force Size Problem - Forward and Backward Recursive equations.

(Chapter 9: Sections 9.1, 9.2,9.3)

Unit III

Deterministic Inventory Models - Probabilistic Models: Continuous Review Model, Single Period Models: Instantaneous Demand, No Setup Cost and s-S Policy

(Chapter 13: Sections 13.1, 13.2, 13.3, 13.4(13.4.1, 13.4.2)

Unit IV

Decision Theory and Games: Decisions under Risk - Decision Trees - Decision under uncertainty- Game Theory.

(Chapter 11: Sections 11.1, 11.2, 11.3, 11.4)

Unit V

Queueing Theory: Elements of Queueing model - Roles of the Poisson and Exponential Distributions - Arrivals Process- Departures Process- Queues with combined arrivals and departures.

(Chapter 15: Sections 15.1, 15.2, 15.3)

Text Book

1. Hamdy A. Taha: Operations Research an Introduction, Fourth Edition, Macmillan Publishing Company, New York, 1987.

Books for Reference

1. J.K.Sharma: Operations Research, Macmillan, Publishers, India Ltd, 2007.
2. KantiSwarup, P.K.Kupta and Man Mohan: Operations Research, Sultan Chand & Sons Publications, 2013.

Semester II			
Elective I A	**Combinatorics**		
Code:19PMAE21	**Hrs/week: 4**	**Hrs/Sem:60**	**Credits: 3**

Vision

To introduce combinatorial techniques for solving enumeration problems.

Mission

To understand and demonstrate the basic concept of an algorithm and its applications in combinatorial mathematics.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	recognize the properties and behavior of permutations and combinations.	1, 6	Un
CO-2	solve problems involving strings, combinations, distributions and partitions.	2	Cr
CO-3	understand the ideas of permutations and combinations.	1,6	Un
CO-4	apply, implement and interpret the theory of combinatorics to relevant probability and statistics problems.	2	Ap
CO-5	understand the addition and multiplication principles of counting.	3	Un
CO-6	apply diverse counting strategies to solve varied problems involving combinations and distributions	2,3	Ap
CO-7	identify, formulate and solve combinatorial problems.	2	Ap
CO-8	apply combinatorial ideas to practical problems	1,6	Ap

Semester II			
Elective I A	**Combinatorics**		
Code: 19PMAE21	**Hrs/week: 4**	**Hrs/Sem:60**	**Credits: 3**

Unit I

Permutations and Combinations:

Introduction, rules of sum and product, Permutations and Combinations, Distributions of distinct objects, distributions of non - distinct objects.

(Chapter 1: Sections: 1.1 -1.6)

Unit II

Generating Functions:

Generating functions for combinations, enumerators for permutations, Distributions of distinct objects into non- distinct cells, partitions of integers.

(Chapter 2: Sections: 2.1 -2.5)

Unit III

Recurrence Relations:

Linear Recurrence relations with constant coefficients, Solution by the technique of generating functions, Recurrence relation with two indices.

(Chapter 3: Sections: 3.1 -3.3, 3.5)

Unit IV

The Principle of Inclusion and exclusion:

The principle of Inclusion and Exclusion, the general formula, Derangements, Permutations with restrictions on relative positions.

(Chapter 4: Sections: 4.1 -4.5)

Unit V

Polya's Theory of Counting:

Equivalence classes under a permutation group, Equivalence classes of functions, Weights and inventories of functions, Polya's fundamental theorem.

(Chapter 5: Sections: 5.3 -5.6)

Text Book

1. C. L. Liu: Introduction to Combinatorial Mathematics, McGraw Hill publications, 1968.

Books for Reference

1. Normal L. Biggs: Discrete Mathematics, Oxford University Press, Oxford, 2002.
2. J.Hein: Discrete Structures, Logic and Computability, Jones and Barlett, 2002.

Semester - II			
Elective I B	**Stochastic Processes**		
Code: 19PMAE21	**Hrs/week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Vision

To develop and apply the knowledge of stochastic process in an uncertain environment.

Mission

To acquire knowledge about stochastic process relying on the probability theory and mathematical analysis.

Course Outcome:

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	understand the stochastic models for many real life probabilistic situations.	8	Un
CO-2	explain the well known models like birth-death and queueing to reorient their knowledge of stochastic analysis.	7	Cr
CO-3	understand the random walk associated with real life situation to solve.	1	Un
CO-4	analyze the transition probabilities and its classifications.	2	An
CO-5	discuss erlang process and execute it.	5	Un
CO-6	apply into real life problems	1,8	Ap
CO-7	understand the notions of stochastic process.	5	Un
CO-8	apply markov chains to practical problems	4	Ap

Semester - II			
Elective I B	**Stochastic Processes**		
Code: 19PMAE21	**Hrs/week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Unit I

Generating functions - Laplace Transforms - Laplace Transforms of a Probability Distribution or of a Random variable - Difference Equations - Difference Equations in Probability Theory.

(Chapter: 1, Sec: 1.1 - 1.5)

Unit II

Differential - Difference Equations - Matrix analysis. Stochastic Process: Notion of Stochastic process - Specification of Stochastic Process.

(Chapter: 1, Sec: 1.6, 1.7 and Chapter: 2, Sec: 2.1 - 2.3)

Unit III

Higher transition probabilities and classification of states - Higher transition probabilities - Classification of states and chains - Determination of Higher transition probabilities -Stability of Markov system: Limiting Behavior.

(Chapter: 3, Sec: 3.1 - 3.5)

Unit IV

Statistical inference for Markov Chains-Markov chains with continuous state space-Non-stationary or Non-homogeneous chains-Poisson process-Poisson process and Related Distributions.

(**Chapter: 3, Sec: 3.6-3.8 and Chapter: 4, Sec 4.1 - 4.2)**

Unit V

Generalizations of Poisson Process-Birth and Death process-Markov Processes-Discrete State Spaces-Erlang Process.

(Chapter: 4, Sec: 4.3 - 4.36)

Text Book:

1. J.Medhi: Stochastic Process, Wiley Eastern Limited, 1982.

Books for Reference:

1. Srinivasan Mehata: Stochastic Process, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1976.
2. Tapas kumar Chandra and Sreela Gangopadhyay: Introduction to Stochastic Process, Narosa Publishing House, 2018.

Semester III			
Elective II A	**Fluid Mechanics**		
Code: 19PMAE31	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 3**

Vision

To empower students with the knowledge of basic laws, principles and phenomena in the area of fluid mechanics and to solve problems.

Mission

Enable the students to apply the acquired knowledge and skills in professional and specialist courses.

Course Outcome

CO.No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	explain fundamentals of fluid mechanics, which is used in the applications of Hydraulics.	1,8	Un
CO-2	employ Archimedes principle to solve numerical examples on Buoyancy.	2,5	Ap
CO-3	develop understanding about hydrostatic law, principle of buoyancy and stability of a floating body and application of mass, momentum and energy equation in fluid flow.	2	Ap
CO-4	imbibe basic laws and equations used for analysis of static and dynamic fluids.	1,8	Un
CO-5	examine stability of submerged and floating bodies.	6	An
CO-6	differentiate horizontal motion and vertical motion.	1	An
CO-7	describe methods of implementing fluid mechanics laws and phenomena.	5,6	Re
CO-8	calculate and optimize operational parameters of hydraulic problems, systems and machines	2	Cr,Ap

Semester III			
Elective II B	**Fluid Mechanics**		
Code: 19PMAE31	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 3**

Unit I

Properties of Fluids: Fluid Mechanics and hydraulics- Definition of a fluid- American engineering system of units- Specific weight- Mass density- Specific gravity- Viscosity- Vapor pressure- Surface tension- Capillarity- Fluid pressure- Unit pressure- Difference in pressure – Pressure variations in a compressible fluid- Pressure head h- Bulk modulus of elasticity- Compression of gases. Isothermal conditions- Adiabatic or Isentropic conditions- Pressure disturbances.

(Chapter 1)

Unit II

Hydrostatic force on surfaces: Force exerted on plane area- Line of action of force- Horizontal and vertical components of force- Hoop tension- Longitudinal stress.

(Chapter 2)

Unit III

Buoyancy and flotation: Archimedes' Principle- Stability of submerged and floating bodies.

(Chapter 3)

Unit IV

Translation and Rotation of liquid masses: Horizontal motion- Vertical motion- Rotation of open vessels- Rotation of closed vessels.

(Chapter 4)

Unit V

Dimensional analysis and hydraulic similitude: Dimensional analysis- Buckingham Pi theorem- Hydraulic models- Geometric similitude- Kinematic similitude- Dynamic similitude- Inertia force ratio- Inertia-pressure force ratio- Inertia-viscous force ratio- Inertia-gravity force ratio- Inertia-elasticity force ratio- Inertia-surface tension ratio- Time ratios.

(Chapter 5)

Text Book

1. Ranald V. Giles: Fluid Mechanics and Hydraulics, Second Edition, McGraw - Hill Book Company.

Books for Reference

1. Dr.R.K. Bansal, A text bookofFluid Mechanics, Laxmi Publication private limited.
2. Joseph H.Spurk,Nuri Aksel, Fluid Mechanics,Secon Edition,Springer- Verlag Berlin Heidelberg ,2008.

Semester - III			
Elective II B	**Wavelet Analysis**		
Code: 19PMAE31	**Hrs/week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Vision

To expose the students to the basics of Wavelet theory and to illustrate the use of Wavelet Processing for data compression and noise suppression.

Mission

To handle problems and conduct researches related to theoretical and applied problems in Wavelet Theory.

Course Outcome:

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	understand wavelet basis and characterize continuous and discrete wavelet transform	2	Un
CO-2	understand multi resolution analysis and identify various wavelets and evaluate their time frequency resolution properties	3	Un
CO-3	analyze discrete wavelet transforms with multirate digital filters	8	An
CO-4	discuss and explain the main merits and limitations of wavelet analysis	2	An
CO-5	explain the properties and applications of wavelet transform	1	Ev
CO-6	apply into real life problems	2,3	Ap
CO-7	explain brief features and strength of transform beyond wavelet.	2	Ev
CO-8	design certain classes of wavelets to specification and justify the basis of the application of wavelet transforms to different fields	1,6	Cr

Semester - III			
Elective II B	**Wavelet Analysis**		
Code: 19PMAE31	**Hrs/week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Unit I

Motivation and Heuristics - Heuristics Treatment of the Wavelet Transform - Wavelet Transform - Wavelet Characterization of Smoothness - Haar Wavelet Expansion - Haar Functions and Haar Series - Haar Sums and Dyadic Projections - Completeness of the Haar Functoins. **(Chapter: 6, Sec: 6.1 - 6.3, except 6.3.4 - 6.3.7)**

Unit II

Multi resolution Analysis - Orthonormal System and Riesz Systems - Scaling Equations and Structure Constants - From Scaling Function to MRA - Meyer Wavelets - From Scaling Function to Orthonormal Wavelet. **(Chapter: 6, Sec 6.4)**

Unit III

Wavelets with Compact Support - From Scaling Filter to Scaling Function - Explicit Construction of Compact Wavelets - Smoothness of Wavelets - Cohen's Extension **(Chapter: 6, Sec: 6.5)**

Unit IV

Convergence Properties of Wavelet Expansions - Wavelet Series in L^P Spaces - Jackson and Bernstein Approximation Theorems. (**Chapter: 6, Sec: 6.6)**

Unit V

Wavelets in Several Variables - Two important Examples - General Formulation of MRA and Wavelets in R^d - Examples of Wavelets in R^d. **(Chapter: 6, Sec: 6.7)**

Text Book:

1. Mark A. Pinsky: Introduction to Fourier Analysis and Wavelets, Published by the American Mathematical Society, First Indian Edition, 2015.

Books for Reference:

1. E. Hernandez and G. Weiss: A First Course on Wavelets, CRC Press, 1996.
2. L. Prasad & S.S. Iyengar: Wavelet Analysis with Applications to Image Processing, CRC Press, 1997.

Semester IV			
Core XIX	**Differential Geometry**		
Code: 19PMAC44	**Hrs/Week: 5**	**Hrs/Sem: 75**	**Credits: 4**

Vision:

To acquire essential ideas and methods of differential geometry and to learn about the classical theory of curves, surfaces and vector methods.

Mission:

To make students understand the basic terms and tools of differential geometry, which will be used in formulating and solving problems.

Course Outcome:

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO -1	construct a variety of geometrical objects.	1	Ap
CO-2	acquire the essential ideas about the theory of space curves.	6	Re
CO-3	understand the concepts of the contact between curves and surfaces.	5	Un
CO-4	analyze the different consequences and meanings of parallelism on Euclidean and hyperbolic planes.	1	An
CO-5	demonstrate the knowledge of the historical developments of Euclidean and Non- Euclidean geometry.	5	Un
CO-6	demonstrate the knowledge of family of curves, geodesics and the fundamental forms.	1,6	Un
CO-7	use concrete models to demonstrate geometric concepts	2	Ap
CO-8	evaluate the principal curvatures, the mean curvature and Gauss curvature of a given surface.	2,6	Ev

Semester IV			
Core XIX	**Differential Geometry**		
Code: 19PMAC44	**Hrs/Week :5**	**Hrs/Sem: 75**	**Credits: 4**

Unit I

The Theory of Space Curves: Introductory Remarks about Space Curves - Definitions - Arc Length - Tangent, Normal and Binormal - Curvature and Torsion of a curve given as the intersection of two Surfaces.

(Chapter 1: Sections 1, 2, 3, 4, 5)

Unit II

Contact between Curves and surfaces - Tangent Surface, Involutes and Evolutes. Intrinsic Equations, Fundamental Existence Theorem for Space Curves - Helices.

(Chapter 1: Sections 6, 7, 8, 9)

Unit III

The Metric: Local Intrinsic Properties of a Surface: Definition of a Surface - Curves on a Surface - Surfaces of Revolution - Helicoids - Metric - Direction Coefficients.

(Chapter 2: Sections 1, 2, 3, 4, 5, 6)

Unit IV

Families of Curves - Geodesics - Canonical Geodesic Equations - Normal Property of Geodesics.

(Chapter 2: Sections 7, 10, 11, 12)

Unit V

The Second and Fundamental form: The Second and Fundamental form - Principal curvatures - Lines of Curvature - Geodesic Parallel - Geodesic curvature.

(Chapter 2: Sections 14, 15 & Chapter 3: Sections 1, 2, 3)

Text Book

1. T.J.Wilmore: An Introduction to Differential Geometry, Oxford University Press, 2007.

Books for Reference

1. Dirk J.Struik: Lectures on Classical Differential Geometry, Second Edition, Addison Wesley Publishing House.
2. William C.Graustein: Differential Geometry, 1962, Dover Publications, New York.